IX. A Forest Management Framework for Massachusetts

The preceding section identifies a number of issues, goals and recommendations related to the management of both state and private forestland in Massachusetts and the Berkshire Ecoregions. However, management planning also occurs within a context of various regulatory, legislative, contractual and other standards and requirements. As a model of sustainable high quality forest stewardship, forest management on state-owned forestland must meet all of these standards and requirements. This section summarizes those requirements, and presents a general "framework" in which the management planning process for state properties will occur.

Overall, forest management on state-owned forestland meets a variety of objectives including the production of timber, fuelwood, and pulp; maintenance and creation of specific wildlife habitats; protection of drinking water supplies; and the provision of recreational opportunities. While the details of this management are best understood through the site specific management plans for each forest, the three land management divisions in Massachusetts conduct forest management within a broad, common framework that assures the sustainability of the practices and provides protection for sensitive resources that occur on all state-owned forestland. This framework includes both regulatory and silvicultural standards to which forest management on state-owned forestland in Massachusetts adheres. There are also common contractual procedures among the agencies – e.g., through which forest products are sold - and some similarities in the range of forest harvesting systems that are permitted to operate on Commonwealth properties.

Each of the EOEA divisions that manage forestland in Massachusetts employs professional forestry and natural resources staff who plan for and implement a wide range of silvicultural activities on these lands in order to meet the mandates and objectives of each agency and property. In general, those staff members are also responsible for developing management plans for those properties. Approximately 80% of state forestland in Massachusetts (not including most state parks and other recreational facilities) is considered to be under *active* management for a variety of resources, including wood products, wildlife habitat, and watershed protection. The remainder is often in a "protected" status, or considered to be under *passive* management – e.g., to establish late-successional forest and/or to conserve unique or sensitive species and habitats. Certain management activities occur across all state-owned forestland in Massachusetts, including boundary management, off-road vehicle management, and control of invasive, exotic species that degrade native forest ecosystems.

Regulatory Standards

All forest management on state lands is subject to a variety of Federal and Massachusetts laws and regulations. Many of these regulations are focused on preventing damage to water and wetland resources, while others protect endangered species and cultural resources, or prevent accidental fire damage. Some of these laws are listed below (NOTE: the full text of Massachusetts General Laws is available at *www.state.ma.us/legis/legis.htm*).

1. Section 404 of the Clean Water Act of 1977 required the US Army Corps of Engineers to control any activities resulting in dredging or filling of waterways, a responsibility that has since been passed on to state agencies.
2. Section 319 of the Federal Clean Water Act Amendments of 1987 tasked the MA DEP with developing Best Management Practices to control non-point source pollution associated with timber harvesting.
3. Section 6217 of the Federal Coastal Zone Act Amendments of 1990 deals with non-point source pollution that affects coastal regions, requiring MA CZM to address any such problems

associated with timber harvesting. All harvesting activities in the state are assumed to have the potential to affect the coastal zone, and are therefore subject to Section 6217 requirements.

4. The Source Water Assessment Program, required by the federal Safe Drinking Water Act Amendments of 1996, requires the MA DEP to assess potential threats to drinking water supplies and determine the susceptibility of supplies to these threats. Forest Operations is among the potential threats identified, though the focus of concerns was on "unregulated logging" (i.e., logging that falls outside the jurisdiction of the Forest Cutting Practices Act, described below).
5. MGL Chapter 48 (Fires, Fire Departments, and Fire Districts), especially Sections 16 thru 20 which deal with the handling of slash resulting from timber harvesting, to minimize fire danger.
6. MGL Chapter 30, Sections 61-62 (Environmental Impact of Projects, etc. Conducted by Agencies) and the Massachusetts Environmental Policy Act (MEPA) regulations (301 CMR 11.00) seek to limit or prevent negative impacts on the environment of the Commonwealth through a review procedure that requires impact reports for activities that exceed certain thresholds. Revisions to MEPA regulations, effective July 1, 1998 determined that MEPA review is not required for forest harvesting operations provided that a Chapter 132 Forest Cutting Plan has been filed, with a few exceptions. An Environmental Notification Form (ENF) and other MEPA review may be required for any non-bridged crossing 1,000 or fewer feet upstream of a public surface drinking water supply for the purpose of forest harvesting activities (bridged crossings do not trigger this review). While many projects that occur within a designated Area of Critical Environmental Concern require MEPA review, forest cutting that occurs in an ACEC under a Chapter 132 Cutting Plan is exempt from this review. Forest cutting undertaken *without* a Cutting Plan (e.g., because less than 25 thousand board feet or 50 cords are to be cut) may be subject to MEPA review if it alters an area in excess of 25 acres or occurs within an ACEC.
7. MGL Chapter 131, Section 40 (the Wetland Protection Act), which subjects any activity that would alter, dredge, fill, or otherwise harm wetlands to strict regulation.
8. MGL Chapter 132, Section 40-46 (the Forest Cutting Practices Act) and 304 CMR 11.00 require filing of a Cutting Plan for any timber harvest that exceeds 50 cords or 25 thousand board feet, except when clearing for public utilities or highways, maintenance cutting in pastures, cutting for the non-commercial use of the landowner, clearing land for cultivation or pasture, or change of use cutting (e.g. clearing house lots or mining gravel). (Note that all of these exceptions are subject to Chapter 131 and other environmental legislation). The act and regulations apply to harvesting on public or private lands, and address wetland protection, wildlife habitat and endangered species, and provide minimum environmental standards to which all regulated harvests must adhere. Chapter 132 also requires licensing of foresters and loggers who work in Massachusetts. If a Cutting Plan has been filed for a harvest, this harvest is exempt from the procedures required by Chapter 131 and is instead subject to wetland and environmental review by the DCR Service Forester assigned to the region.
9. 314 CMR 4.00 (Massachusetts Surface Water Quality Standards) provides additional protection for Outstanding Resource Waters, which are waters with exceptional socio-economic, recreational, ecological and/or aesthetic values (such as public drinking water sources). This protection extends to 304 CMR 11.00 cutting practices regulations, for instance by requiring that stream crossings by logging equipment within 1,000 feet upstream of a public water supply must use a temporary bridge or undergo MEPA review.
10. Federal and Massachusetts endangered species laws and regulations. MGL Chapter 131A (Massachusetts Endangered Species Act) prohibits the taking of any listed MA species. DCR Service Foresters are required to compare a proposed harvesting area on a Cutting Plan to the atlas of listed species habitats provided by the Natural Heritage program, and to contact NHESP for protection guidelines if these overlap.
11. Federal and Massachusetts laws for preservation of historic or prehistoric cultural resources do not apply until sites have been officially listed in the State or National Registers of Historic Places, or have been officially documented to contain prehistoric resources of significance. No

such sites exist to date within Massachusetts state-owned forestland. However, there are agency mandates for the protection of such sites, and minimum standards are evolving.

Among these and the many other laws and regulations that may impact forest management activities in Massachusetts, the Forest Cutting Practices Act and regulations are the most prominent set of rules regularly affecting forest management on state (and private) forestland. The Massachusetts standard upheld by this act is among the three or four most stringent in the nation, in the company of regulations in the states of Oregon, California, and Maryland. Listed below are some of the minimum environmental standards of these regulations that apply to forest management on all state-owned (as well as private) forests.

1. All trees to be cut (or, in some situations, to be left as seed sources) must be designated by marking, or by a detailed description in the forest cutting plan of the size, species, and quality of trees to be cut and the percentage of the basal area (stocking of trees) to be removed. Management objectives and silvicultural methods must be identified in the cutting plan.
2. Regeneration cuts (including selection system, shelterwood, seed tree, and clear cuts) require either the presence of 1,000 or more viable stems of regeneration per acre, the planting or direct seeding of this many trees, or verification that this condition will be met naturally within five years or fewer. The vast majority of management objectives are met through natural seeding. Intermediate cuts (thinnings) must meet minimum standards for residual stocking.
3. Seed tree and clear cut silvicultural systems also have additional requirements. Seed tree cuts are subject to specific requirements for the number and size of overstory trees left behind. The maximum clear cut opening size is ten acres unless the source of the regeneration is seeding from surrounding stands, in which case the maximum size is five acres. Clearcuts larger than these limits require an approved justification stating the ways in which environmental effects will be reduced, or environmental benefits enhanced by a larger opening size. As noted above, clearcuts in excess of 25 acres require the filing of an ENF.
4. Filter strips are required along all water bodies and certified vernal pools. The width of these strips is at least 50 feet, but increases with slope for streams wider than 25 feet, ponds 10 acres or greater, designated scenic rivers, and along Outstanding Resource Waters and their tributaries. Also, for all water bodies where the filter strip is 30% or greater in slope, the minimum width increases to 100 feet or to the point between 50 and 100 feet at which the slope drops to less than 30%. Clearcuts are not allowed within the filter strip, with some exceptions. Cutting in filter strips is limited to 50% of the basal area and the trees left behind must be healthy and well-distributed. Equipment is not allowed to operate within the filter strip except to access an approved stream crossing.
5. Roads must be designed, mapped, constructed, and maintained according to standards of drainage, erosion control, and slope limitations.
6. Landings must be placed at a sufficient distance from wetland and water resources, must be designed and built properly to limit erosion, must be kept free of trash, and must be stabilized at the end of use.
7. All regulated wetland resource areas must be accurately mapped in the cutting plan and logging is subject to a wide array of restrictions, including where, when, and how equipment is allowed to work on or near wetlands.
8. Stream and wetland crossings are required to meet minimum Best Management Practices (see Kittredge, D.B. and M. Parker, 1995. Massachusetts Forestry Best Management Practices Manual, available through DCR/DSPR Regional offices), with stronger restrictions for stream crossings within 1,000 feet upstream of a public water supply reservoir.

The above is by no means a comprehensive listing – these are simply examples to illustrate regulations for those unfamiliar with the Forest Cutting Practices Act. The full text of these regulations is available online at *www.state.ma.us/dem/regs/304011b.htm*.

Management Planning

The development of site-specific forest or land management plans is a very important component of the overall management framework for state-owned forestland. The planning process starts with a review of the mandates or guiding principles that apply to a particular property. In some cases, these are legislative mandates, although more often they are in the form of agency or division mission statements and policies that are essentially interpretations of the legislation that created or guides the agency or division.

Good management requires good data, so inventorying and describing the natural and cultural resources of a property is an important component of management planning. Data on forest and other habitat or natural community types, rare species, geologic, soil and hydrologic features are all needed. Typically, remote sensing (e.g., aerial photo interpretation) provides general forest cover type information at the landscape level. However, whenever feasible and appropriate, the Natural Community Classification for Massachusetts (Swain and Kearsley, 2001) - which utilizes field assessments to provide more detailed vegetation descriptions than the more general forest cover types, and thus can be used to partition large, heterogeneous forest stands into more distinctive, homogeneous natural communities - will be used.

One of the more important parts of the land management plan is the section on goals and objectives, since these dictate why and how that land will be managed. While management goals are necessarily property-specific, they will relate back to those issues and goals identified in the appropriate ecoregion(s) document as much as possible.

Areas that have been designated as forest reserves will be clearly described and mapped in each property management plan. Other areas to be protected (e.g., vernal pools, BioMap core habitats) or acquired (e.g., areas identified in the Statewide Land Conservation Plan and agency land committees) will also be identified and mapped in the management plan.

Public input into the management of state-owned forestland is very important, and public meetings and other opportunities for the public to actively engage in the planning process will be a component of each property's plan. Opportunities for periodic public reviews of the progress being made in implementing management plans will also be provided. Such reviews provide a means of accountability for the managers of these public resources.

Coordination with other agencies and divisions during the management planning process is also essential. For example, many state-owned forests are used heavily for recreation, so forestry activities must be planned with public safety, aesthetics and other potential conflicts in mind. Likewise, management of DSPR and DFW properties in the DWSP watersheds must be particularly mindful of water quality concerns.

Management plans include a long-term monitoring component so that conditions and changes in the forest, both due to natural and anthropogenic disturbances and processes, can be tracked over time. Further, state-owned forestland often provides excellent research opportunities. Especially as forest reserves "age," the opportunities to study ecological conditions in these areas will become increasingly significant.

Finally, good record-keeping is crucial in forest and land management programs. With recent advances in GIS and GPS technologies, record-keeping can incorporate enhanced mapping and geo-referencing of inventory and management information.

Silvicultural Standards

Silviculture involves the deliberate manipulation of forest stands to enhance the long-term attainment of a wide variety of goals – timber production, wildlife habitat creation and maintenance, aesthetic characteristics, recreational experiences, or drinking water supply protection, for example. Silviculture utilizes timber harvesting to deliberately adjust forest structure and composition to meet long term goals. In contrast, timber harvesting conducted in the absence of a long-range silvicultural plan focuses on short-term economic gains from the extraction of merchantable products. This is an important distinction. In Massachusetts, all timber harvesting on state-owned forestland is a component of long-range silvicultural planning and is designed and implemented in a manner that sustains the ability of that forest to meet long-range agency and division objectives while protecting natural and cultural resources on the site.

Timber harvesting that focuses on maximizing short-term revenue by cutting only the best, most valuable trees generally qualifies as "high-grading" of the forest. High-grading is not considered to be silviculture (because it degrades the long-term productivity of the forest), and therefore will not occur on state-owned forestland in Massachusetts. Similarly, **commercial clear-cutting**, in which all merchantable trees are stripped from a forest stand, leaving behind only trees with no value, is an extreme form of high-grading, is also not silviculture, and will not occur on state-owned forestland in Massachusetts. By contrast, a **silvicultural clear-cut** removes all trees from a designated area, reassigning all growing space to regeneration with high potential for vigorous growth and development. Silvicultural clear-cutting is a valuable silvicultural tool occasionally employed on state-owned forestland in Massachusetts.

Across the wide range of forest conditions and agency and division mandates within the state-owned forestland in Massachusetts, an equally wide range of silvicultural practices has been used and is proposed for use in the future. This range of practices is very generally described below, in the interest of providing readers with some idea of what they might encounter on a visit to one of the managed state-owned forest properties in Massachusetts. The range of practices is fully described in management planning documents prepared by each agency, and the specifics of any individual treatment are written in cutting plans that can best be described in detail by the professional forester in charge of the operation. Silvicultural treatments vary with the age and the stage of growth of the forest stand (an area of similar tree species and age composition and distinct from adjacent areas is a "stand"). In young stands, **intermediate treatments** are often employed to improve the growth and vigor of the most desirable trees for meeting stand objectives. When stand objectives call for the harvesting of mature overstory trees, this removal generally occurs in at least two stages: **regeneration establishment** and **regeneration release** cuttings, although regeneration may also be planned to *follow* the removal of the overstory, either through natural seeding or through artificial planting, in which case the harvest would be more appropriately termed, simply, an overstory removal. In selection systems, both intermediate and regeneration components are done within the same entry in order to create or perpetuate a stand with three or more age classes. These treatments and some other general silvicultural principles are described below, although no attempt has been made to provide a comprehensive description of silviculture on state-owned forestland in Massachusetts.

Intermediate treatments: These treatments include a wide variety of thinnings, generally referred to as improvement thinnings. The objective of the thinning may be to simply reduce the number of trees per

acre, or may also seek to reduce the number of poorly-formed or low-vigor trees in order to shift the growing resources to trees of better quality. Thinnings also sometimes focus on shifting the species composition, for instance by removing poor quality red maple and birch to encourage the growth of oak trees in a mixed hardwood stand, in order to realize the substantial habitat benefit from acorns, and the economic value of oak timber.

Regeneration establishment *(a.k.a. preparatory cutting):* A common objective of silviculture is to assure the presence of desirable and vigorous seedlings and saplings in the understory, in order to set the stage for the next forest when the current stand is harvested. The forester carefully manipulates light conditions through thinnings and may also call for loggers to deliberately "scarify" the accumulated organic litter in order to encourage the success of a particular species. Some species are much more difficult to establish than others and may require **enrichment plantings** to ensure their presence in the future stand. For example, supplementing the sometimes inadequate natural regeneration of oaks by planting oak seedlings, or planting white pine on an oak-dominated upland in order to reduce the future stand's susceptibility to gypsy moth damage.

Regeneration release*:* The successful establishment of regeneration can take many years. Soon after it is established, however, regeneration will stagnate and eventually may perish if it is not released from the shade of overstory trees so it can grow and develop. This requires the removal of additional overstory trees, either individually or in groups ranging from $1/10^{th}$ acre to multiple acres in size. These cuttings release the understory seedlings and saplings to become either a new stand or a new age-class within an uneven-aged stand (see next topic).

Even-aged and uneven-aged silvicultural methods: While any forest is likely to include trees of many ages, individual stands of trees are either even-aged (all of about the same age, or two distinct age classes) or uneven-aged (at least three distinct age "classes" within the stand). Natural disturbances can create either condition, depending on the size of the disturbance. For instance, a catastrophic wind event might blow over the entire overstory of a stand, so that the stand that eventually takes its place is started at about the same time (within about ten years of the initiating disturbance). On the other hand, small-scale disturbances such as the death of individual trees and small groups of trees due to pests or disease leave behind a stand with many different age groups or "cohorts." The vast majority of Massachusetts forests, state and private, are even-aged, as a result of farm abandonment at the turn of the century and large-scale disturbances such as the hurricane of 1938.

Professional foresters working on state-owned properties in Massachusetts conduct silvicultural practices that reflect the range of naturally-occurring conditions. **Single tree and small group selection** methods remove the overstory from only a portion of the stand, resulting in a stand that eventually contains at least three distinct age classes, an uneven-aged stand. Silvicultural clearcutting removes the overstory all at once in circumstances in which regeneration of desired tree species can best be accomplished with a single, full overstory removal cut. The **shelterwood system** removes the forest canopy in two or three stages over approximately 20-30 years. Both clearcutting and shelterwood cutting result in an even-aged new stand.

It is common on state-owned forests for managers to apply varieties of the standard silvicultural practices described above. Examples include “irregular” shelterwood cutting (which can be seen on both DWSP and DFW lands), and “aggregate retention cutting” (which can be seen on DFW lands). Irregular shelterwood typically involves the retention of some overstory trees into or beyond the next rotation in order to provide aesthetic benefits, as well as structural diversity and associated wildlife habitat benefits in managed forests. Aggregate retention cutting typically involves the retention of clusters of overstory trees throughout what would otherwise be a clearcut, in order to maintain cool, moist microclimates

within the cut area. These areas help conserve various salamanders and other wildlife species with limited dispersal capabilities and hasten the re-establishment of continuous forest canopy across the site.

The choice of silvicultural method used to treat a stand depends on an almost endless combination of variables. If the principal objective for managing the stand is to realize the highest possible long term value from harvesting wood products, intermediate and regeneration treatments will be organized around market values, the productive capacity of the site ("site index"), and the opportunities to grow and regenerate specific species. For instance, the highly-valued oak species in our forests are best established in the shade of a shelterwood preparatory cut, but may eventually require large openings to provide enough light for oak to compete successfully with other species. If stand objectives included the perpetuation of a stand of sugar maple, this shade-tolerant species is best regenerated using single tree and small group selection methods in an uneven-aged system. The scarcity of early-successional habitats (seedlings and saplings) identified elsewhere in this document may recommend that some relatively large full overstory removals occur on state-owned forest properties in Massachusetts where creating a diversity of forested habitats for wildlife is a guiding objective. The desire to encourage exceptionally large diameter trees in some state-owned stands may argue for simply doing nothing, or might be best met through gradual, continuous individual tree and small group selection cutting.

Rotations and cutting cycles: It is probably common for a visitor who encounters a timber harvest on Massachusetts state-owned forestland to wonder how frequently harvesting will take place in this area. Once again, a very wide range of variables dictate this schedule, but there are some general guidelines that affect all Massachusetts state-owned forest properties. In long-range silvicultural planning, two general principles apply to the timing of operations: rotation and cutting cycle. The **rotation** is the expected maximum age to which the trees in a given stand will be grown before they are harvested. There are methods for calculating the point at which a tree of any given species slows in value growth to an economically unacceptable pace, at which point a strictly financial analysis would recommend that the tree be harvested (and replaced with a younger one). The age of this *financial* maturity might be used as the rotation point of the stand. So if a pine stand is being grown to produce wood and revenue, it might be grown for just 70 to 80 years, even though the point of *biological* maturity (the age at which the tree would begin to die of natural causes) would occur considerably later. On state-owned lands, the rotation age is often set beyond the age of financial maturity in order to realize non-commodity attributes of the forest such as wildlife habitat or aesthetic or recreational values. In these cases, an **extended rotation** is applied, which falls somewhere between the points of financial and biological maturity. Extended rotations will also occur in stands that are very low priority for active management, or when the primary objective in a stand is to create late-seral forest conditions.

As it matures toward the rotation age, the stand might be thinned several times for reasons described above. The frequency with which the stand is entered to conduct intermediate treatments is the **cutting cycle**. On actively managed Massachusetts state-owned forests, cutting cycles are commonly in the 15 to 50 year range, although there are exceptions. For instance, as a white pine stand approaches the desired rotation age, it may be regenerated through a series of preparation and removal cuts that take place within 5 to 10 years of each other, and an intensively managed uneven-aged stand may require entry every 10 years. These are the exceptions. In general, a visitor can expect that actively managed properties will be treated only once every 15 to 50 years.

Salvage cutting: When a stand is badly damaged by insects, disease, fire, wind, ice, or snow, foresters must decide whether it is more desirable to salvage the damaged timber or to let the stand recover gradually without intervention. These disturbances are generally unplanned disruptions of long-range objectives, and salvage harvesting is only silviculture to the extent that it prepares the stand to recover from the disturbance. These disturbances can eliminate some silvicultural options, for instance when a wind event removes a shelterwood overstory and allows shade intolerant species to compete with the

desired regeneration species. Where disturbances present a public safety hazard or involve valuable timber, there may be a strong incentive to initiate a salvage operation. There are areas and circumstances where salvage is not desirable, for instance when risks associated with the salvage effort exceed the potential gains from salvaging (for example, when the damaged stand is on a steep slope or on wet soils adjacent to water resources).

Summary

The **common components of silviculture across the state** include, among others:

1. All timber harvesting on Massachusetts state-owned forests is a component of long-range silvicultural planning and is designed and implemented in a manner that sustains the ability of that forest to meet long-range agency objectives while protecting natural and cultural resources on the site.
2. Some timber harvesting practices are not components of a long-range, silvicultural approach and will not occur on state lands. These include high-grading (cutting only the best, most valuable trees) and commercial clear-cutting (removing all merchantable trees but leaving all unmerchantable trees standing).
3. Silviculture on state (and private) lands generally progresses through three broad types of treatment; intermediate treatments (thinnings), regeneration establishment, and regeneration release cuttings. These cuttings support either even-aged or uneven-aged systems of silviculture, or systems that bridge the two.
4. While rotations (the target maximum age to which a stand will be grown) are generally 80 to 150 years or more on state lands (longer for stands aimed at producing late-seral stage conditions), cutting cycles (the frequency with which a stand is treated) will range from 15 to 50 years.
5. Salvaging of damaged forest stands may or may not occur on state lands, depending on the objectives for the stand, the accessibility and sensitivity of the damaged area, and the value of the damaged timber.

Contractual Standards and Cutting Plans

In Massachusetts, when the plan for a given stand within state-owned forestland calls for a harvesting operation to take place, a licensed professional forester reviews the stand, marks (commonly with blue paint) the trees to be cut, measures both their diameter at breast height and height in log length to estimate their merchantable volume. Rarely, a harvest area is so homogeneous or of such low value that the trees are not individually marked. For instance, in a heavy overstory removal cut in a stand of very poor timber quality "pasture pine" or in a final removal cut in a uniform red pine plantation, some trees may be marked for retention while all *un*-marked trees are cut. In these cases, the boundaries are carefully marked and the total area carefully measured, but volumes to be cut are estimated from a series of representative plots within the total harvest area.

Timber harvesting that takes place on state-owned forestland in Massachusetts is subject to Commonwealth contract and bidding procedures and to the Forest Cutting Practices Act and regulations. Once the wood to be sold has been marked or otherwise identified, a timber sale is described using the agency's timber harvest permit or contract format. These documents include estimates of volumes to be sold, by product (sawlogs, firewood, pulp, poles) and by species. They also may include specifications for equipment to be used (e.g., a limitation on ground pressure or width, or a requirement that a particular piece of equipment be used because of site limitations). The timing of the operation is specified, and the procedures for bidding and paying for the lot are detailed. Lots are then advertised through newspaper announcements, the internet, and/or a mailing to a list of prospective bidders. The advertisement includes a date when the lot will be shown to prospective bidders. At this showing, the forester walks the lot and

describes where roads, stream crossings, and landings will be placed and a wide variety of other conditions specific to the lot. A date is established by which all interested bidders must submit a sealed bid. At a specified time and date, these bids are opened. Generally, the highest bid from a contractor whose equipment meets the standards is accepted. However, the agency reserves the right to reject any and all bids, for instance if the prices bid are below the minimum expected.

While DSPR, DWSP, and DFW permit timber harvesting under agency contracts or permits to harvest, there are common features in these documents, listed below:

1. A non-refundable deposit is required at the time of bidding, to secure the bidders intent to follow through with harvesting.
2. In addition, a performance bond must be posted, which is only returned once the logger has completed the harvest and followed procedures to "put the lot to bed" (e.g. by cleaning and seeding landings, placing water bars as needed on skid trails, and removing temporary stream crossings). The performance bond also provides significant leverage during the operation. If a logging contractor fails to meet performance standards, for instance by excessively damaging unmarked trees, he may sacrifice his bond and may ultimately be removed from the list of potential bidders for future agency timber sales if the problems continue.
3. Harvesting contractors/permittees are required to hold the Commonwealth and its employees harmless from and against any claims arising from their activities during the course of the harvesting operation.
4. Payments for lots are generally required either in lump sum before the lot is started or in a series of payments as fractions of the lot are started (usually when the total bid is large).
5. A specific timeframe is designated during which the lot must be completed, although also included is the option of a time extension for specific reasons. Failure to complete the lot in the specified timeframe can result in the operator losing both the performance bond and rights to timber remaining on the lot.
6. Provisions are made for the forester in charge to temporarily suspend harvesting activities due, for instance, to soil conditions (the arrival of mud season), extreme fire danger, or wildlife considerations (breeding seasons).
7. Haul roads, skid trails, and landings are addressed in the plan. Generally these are either laid out in advance by the forester, or subject to forester approval.
8. Utilization standards are specified. These may include a tip diameter to which all products must be utilized and removed from the site, and on some contracts also specify a minimum amount of coarse woody debris that must be left on site at the conclusion of the lot.
9. The danger of fire is covered in the permit/contract, with specifications for preventing its ignition and spread. These include requirements for the treatment of slash and general recommendations for handling flammable materials.
10. Treatment of slash is specified. At a minimum, this treatment must follow the Slash Law, MGL Chapter 48, section 16.
11. The possibility of oil spills (motor oil, diesel fuel, hydraulic oil, bar and chain oil and gas) is addressed. Permits/contracts require that operators carry a "spill kit" that includes sufficient oil-absorbing cloth to protect soil and water resources in the event of a spill. Specifications are included for the handling of hazardous materials, including a statement of liability for the clean-up of accidental spills.
12. In addition to hazardous materials, requirements are included for the removal of all waste materials, including garbage, trash, litter, discarded equipment or parts, and all other waste. For areas with sensitive water resources, specifications are also included for toilet facilities and the treatment of human waste.

In addition to the timber sale contract, a cutting plan is completed to meet the requirements of Chapter 132. This plan includes a locus map and a detailed map of the harvest area including roads, landings, wetlands, and wetland and stream crossings. Details of the cutting plan are partially listed under the section above on Regulatory Standards. The operator is identified on the cutting plan, including his/her Timber Harvester License number. The silvicultural methods are identified and described in detail where necessary and the volumes of products by species that are being sold are listed. This cutting plan is submitted to the DCR Service Forester responsible for the area in which the harvest will take place. The landowner is required to notify the Conservation Commission in the associated town, and that Commission has ten days in which to comment if they so desire. Abutters are also notified. The Service Forester compares the harvest area to the areas identified by Natural Heritage as being critical habitats for listed Massachusetts species. If the harvest overlaps a critical habitat, then Natural Heritage is required to either indicate that there is no conflict or to work with the forester to determine limitations (for instance, staying out of a turtle breeding habitat during breeding season). Once these procedures have been met, the harvesting contractor may set up to begin cutting the lot, under forester supervision.

Timber Harvesting Systems

The business and science of harvesting timber has changed dramatically in the past 40-50 years. At the turn of the last century, horses and oxen were still the principal means of pulling logs from the forest. This eventually gave way to small crawler tractors pulling a sled for loading logs, and then to center-articulated log skidders with cable winches. These skidders grew in power and operator safety features, but remained the standard for many years. Cable winches were supplemented with grapples that enabled an operator to pick up a load of logs without leaving the safety of the cab, but the initial felling, limbing, and bucking of logs continued to require a chainsaw operator exposed to the worst dangers of logging. In the past couple of decades, this has changed as well, with the arrival of sophisticated harvesting and processing machines. The simplest of these is the mechanical feller, which allows the operator to remain in the protective cab while felling the tree with a machine-mounted saw or shear. More sophisticated machines, feller/processors, first grab the tree, then cut it free from the stump, lay it down at the desired angle, and then delimb, buck, and pile it in place. These machines are equipped with heated/air conditioned enclosed cabs, sophisticated controls, and computers. Toothed rollers move the log through the delimbing arms and also allow the computer to track lengths and diameters for accurate and efficient tracking of production. To complete the harvest, cut-to-length products are removed using forwarders, a machine that loads logs onto a bunk or trailer and carries them out of the woods. At the time of this report, mechanized harvesting is growing rapidly in popularity among Massachusetts timber harvesters, although chainsaw felling and skidders are still common. The move to full mechanization can require equipment purchases of $500,000 to $1 million per business, which is a strong deterrent for small operators, despite the dramatic increase in production and safety.

Along with the increased size and complexity of harvesting equipment have come some increased risks to forest resources, requiring greater care by the operator. Although wider, high floatation tires reduce ground pressure, they add width to the machines, which reduces their ability to work in tight stands being partially harvested. While mechanical harvesters can provide surgical precision in felling operations, they must travel to within reach of every tree. Even with wider tires, a fully loaded forwarder produces ground pressures that can exceed those of a typical loaded skidder. On the other hand, forwarders eliminate the damage to residual trees associated with dragging logs behind a skidder, and allow the wood to be removed to a much smaller and cleaner landing area as all the bucking to length is completed in the woods. Perhaps the greatest concern associated with all harvesting machines is the volume of hydraulic fluid they carry on board to operate the sophisticated clamping, cutting, lifting, and processing capabilities of the machines. At a minimum, these have required the development of related Best Management Practices to reduce the likelihood of a damaging spill. As mentioned above, state

timber sales increasingly require operators of logging machinery to carry special oil-absorbent padding and other materials (a "spill kit") to quickly mitigate the potential adverse impacts of any accidental fluid leak. With careful operation and monitoring, this equipment in total can result in great improvements in safety and productivity, and can also reduce the net impact of the harvesting operation on other resources. Operated poorly and without supervision, the opposite is true.